RECLAIM THE SILENCE

Differential Spectral Tinnitus Detection & Adaptive Sound Therapy

User Manual — v4

IMPORTANT NOTICE — READ BEFORE USE

This product is a research-stage self-help tool. It is NOT a medical device, NOT a diagnostic instrument, and NOT a treatment or cure for tinnitus or any other condition.

Always have new or changing tinnitus assessed by an ENT physician (otolaryngologist) or audiologist before using this system. Tinnitus can be a symptom of conditions that require prompt medical attention (e.g., sudden hearing loss, vestibular schwannoma, vascular disorders).

Discontinue use immediately if your symptoms worsen, or if you experience pain, dizziness, or new hearing changes, and consult a physician.

1. What This Manual Covers

This manual explains how to use the RECLAIM THE SILENCE system: an in-ear-microphone-based measurement method that estimates the frequencies associated with your tinnitus, and a companion sound-therapy engine that generates a personalized notched sound signal. It also gives a brief, non-technical explanation of tinnitus itself, so that the logic behind each step makes sense.

2. Tinnitus in Brief — Why This Approach Exists

2.1 What tinnitus is

Tinnitus is the perception of sound (ringing, hissing, buzzing) without any external acoustic source. It affects roughly 10-15% of adults, with 1-2% experiencing a severe impact on quality of life.

2.2 What is currently understood about its origin

Most tinnitus follows damage to the inner ear (cochlea), commonly from noise exposure, aging, or ototoxic medication. Two mechanisms are thought to contribute, and current research does not consider them mutually exclusive:

- Central mechanism: after the ear sends less signal to the brain (due to hair-cell damage), the auditory brain turns up its internal ‘gain’ to compensate. This overcompensation can be perceived as a phantom tone, and emotional/attentional circuits can reinforce that perception.
- Peripheral (cochlear) mechanism: the cochlea is not a passive receiver — outer hair cells actively amplify vibration. When damage reduces the natural damping of this feedback system at a particular location, that location can begin to oscillate on its own, similar to a microphone squealing near a loudspeaker. This self-oscillation is a real, physical, and in principle measurable acoustic event, not merely a neural construct.

These two mechanisms can act together: a real peripheral oscillation provides the initial signal, and the brain's compensatory amplification and emotional weighting make it more prominent and harder to ignore.

2.3 Why tinnitus is usually a ‘chord’, not a single tone

Contrary to the traditional idea of tinnitus as one pure tone, published measurements show that most tinnitus percepts are a narrow cluster of several simultaneous frequencies — closer to a chord than a single note. This is one reason single-slider matching apps often struggle: they can only capture one component of a multi-frequency percept.

3. How the Measurement Works

Unlike conventional tinnitus apps, which ask you to manually move a slider until a tone ‘sounds like’ your tinnitus, this system attempts to measure a physical correlate of the affected cochlear region directly, using consumer noise-cancelling (ANC) in-ear headphones with a built-in microphone.

3.1 The basic idea

Two short recordings are taken with the same headphones in ANC mode:

- A baseline recording with the earphones NOT inserted in the ear (capturing electronics and room noise only).
- An in-ear recording with the earphones sealed in the ear canal (capturing electronics, room noise, AND any faint sound generated by your own ear).

Subtracting the baseline spectrum from the in-ear spectrum cancels out the electronics and the environment, leaving mainly the narrow-band acoustic signals your own ear is producing — including, in many people with tinnitus, activity related to the affected cochlear region (related to phenomena such as otoacoustic emissions).

3.2 Why ANC mode specifically

Active noise cancelling headphones already contain two microphones and signal-processing that actively cancels sound coming from outside the ear, while sound generated inside the sealed ear canal cannot be ‘cancelled’ by that same processing, because it never reached the outward-facing microphone first. In effect, the headphones' own noise-cancelling circuit acts as a built-in filter that suppresses external noise and leaves faint internally-generated sound more exposed on the internal microphone — which is what the measurement relies on.

The system also automatically filters out electronic artifacts (for example, faint interference from the headphones' own wireless radio) so that they are not mistaken for biological signal.

4. Step-by-Step: Taking a Measurement

Phase 1 — Baseline (about 15 seconds)

Put your ANC-capable in-ear headphones in ANC mode but do NOT insert them in your ears. Hold them still in a quiet room and start the baseline recording.

Phase 2 — In-ear (about 15 seconds)

Insert the same headphones snugly into your ears, keeping ANC mode on, in the same quiet room, and start the in-ear recording. Sit still and avoid talking, swallowing, or moving during this recording, as this can create artifacts.

Phase 3 — Analysis

The system automatically computes the difference between the two spectra and classifies the resulting peaks as likely human (biological), electronic artifact, or too weak to classify. This step requires no action from you.

Phase 4 — Generating your sound

Based on the detected frequencies, the app builds a personalized filtered sound (see Section 5) that you can play back live or export as a WAV file.

Tips for a reliable measurement

Use the same headphones for baseline and in-ear recordings.
Choose the quietest room available; avoid fans, traffic noise, or other people talking.
Keep the headphones and your head still during both recordings.
If a measurement looks inconsistent, simply repeat Phases 1-2.

5. The Sound Therapy

5.1 The ‘Mexican Hat’ filter

For each frequency identified as related to your tinnitus, the system applies a three-part filter to a background sound (by default, pink noise):

- A central notch directly at your tinnitus frequency, reducing energy at that frequency.
- A gentle boost just below that frequency.
- A gentle boost just above that frequency.

This shape is intended to reduce input exactly at the affected frequency while stimulating the immediately neighboring, healthier frequency regions — a principle related to lateral inhibition described in prior published research on notched sound therapy.

5.1.1 The neuroscience behind the flanking boosts: lateral inhibition

The rationale for the flanking boosts is not merely intuitive. Using magnetoencephalography (MEG), Pantev et al. (2004, European Journal of Neuroscience) directly compared two distinct mechanisms by which the auditory cortex's response to a tone can be reduced: passive habituation, where the response simply fades with repeated exposure, and active lateral inhibition, where neurons tuned to a given frequency are actively suppressed by activity in neighboring frequency channels. They found that lateral inhibition produced a stronger and faster reduction of the cortical response at the target frequency than habituation alone, and that stimulating the flanks of a frequency band actively drives this inhibitory suppression of the centre. Building on this mechanism, Okamoto et al. (2010, PNAS) applied ‘tailor-made notched music’ — ordinary music with a narrow band removed precisely at each patient's tinnitus frequency — for about one hour daily over an extended period, and observed a reduction in both subjective tinnitus loudness and the amplitude of the cortical response specific to the tinnitus frequency, consistent with the notch driving sustained lateral inhibition of that frequency channel.

The central notch and flanking boosts used in this system apply that same principle to each individually detected tinnitus frequency: removing energy at f_c while adding it at $0.955 \times f_c$ and $1.045 \times f_c$ is intended to actively recruit neighboring-channel activity to inhibit the target frequency, rather than relying on passive habituation alone. Note that Pantev and Okamoto's work targeted a single, psychoacoustically matched tinnitus tone; extending it here to multiple, objectively measured frequencies and to a noise-based (rather than music-based) carrier is a plausible but not separately clinically validated adaptation of their findings.

5.2 Why the sound keeps shifting slightly (‘Neural Mirage’)

If the exact same filtered sound were played for weeks, the brain would likely adapt to it (habituate), reducing any benefit and making the tinnitus easier to ‘find’ again in the sound. To counter this, the filter position, depth, and left/right balance drift gently and continuously within safe bounds around your measured frequency, so the general therapeutic shape is preserved while the exact pattern keeps changing.

5.3 Stages of use

The app offers three intensity stages, intended to be used progressively over a period such as 12 weeks, moving from a stronger initial setting toward a gentler one as you go:

- ACUTE — strongest notch and boost, most frequent attention clicks.
- MODERATE — reduced intensity.
- RESOLVED — mildest setting, for maintenance.

An Expert Mode allows limited fine-tuning of notch depth and boost strength around each stage's defaults. The filter width is fixed and cannot be changed, as this is set to preserve the intended effect.

5.4 Custom sound source

Instead of pink noise, you may load your own audio sample (e.g. wind, ocean, or nature recordings). The same personalized filter is applied to your chosen sound; short samples are looped automatically.

5.5 Stochastic attention clicks — and why the timing is randomized

In addition to the continuous filtered background sound, brief clicks (about 25 ms) are periodically inserted at each detected tinnitus-related frequency. These are intended as attention-anchors on the flanking, healthy frequency regions rather than as a masking element in their own right.

The rationale for randomizing their timing (3–11 s between clicks, plus a small random pitch/FM modulation) rests on a well-established body of auditory-neuroscience evidence, distinct from the lateral-inhibition mechanism above. Neurons in the auditory pathway show pronounced stimulus-specific adaptation: their response to a repeated, predictable stimulus shrinks progressively with each repetition (Ulanovsky et al., 2003, Nature Neuroscience). Conversely, rare, temporally unpredictable ('oddball' or deviant) stimuli continue to evoke a comparatively large, non-habituating neural response and preferentially capture attention — a phenomenon documented extensively in the mismatch-negativity literature (Näätänen et al., 2007, Clinical Neurophysiology). A click delivered at a fixed, predictable interval would itself quickly become just another repeating pattern that the brain adapts to, defeating its purpose. The clicks in this system are therefore deliberately irregular in timing and pitch, so that, acoustically, they continue to behave as unpredictable deviants rather than as a new periodic stimulus the auditory system can learn to ignore.

This is an engineering application of general principles from auditory adaptation and deviance-detection research, not a claim backed by a dedicated clinical trial of this specific click paradigm in tinnitus patients; its benefit for tinnitus specifically has not been separately proven.

6. Warnings and Limitations

Medical warning

This system does not diagnose tinnitus or any ear condition, and it is not a substitute for examination by an ENT physician or audiologist.

New, sudden, one-sided, pulsatile, or rapidly worsening tinnitus should be evaluated by a physician promptly, as it can (rarely) indicate a more serious underlying condition.

Stop use and seek medical advice if your tinnitus, hearing, or general wellbeing worsens while using the system.

Do not use at volumes that are loud or uncomfortable. Follow safe-listening guidance for headphone use.

Technical limitations you should be aware of:

- Measurement accuracy depends on your specific headphone model and its microphone/ANC characteristics.
- The method does not detect every type of tinnitus; tinnitus that is generated primarily in the central auditory pathways (rather than the cochlea) may not produce a measurable peripheral signal, in which case the measurement may return no clear result.
- No formal clinical trials of effectiveness have been conducted for this system to date. Any benefit is not guaranteed.

7. Liability

The developer of this system accepts no liability for direct or indirect harm arising from the use of the described methods or software. Use is entirely at your own risk. This manual and the underlying methods represent an experimental research project and are not a certified medical device.

8. Quick Reference

Before you start, every time

1. Same headphones, ANC on, quiet room.
2. Baseline (out of ear) → 15 s.
3. In-ear (sealed, still, silent) → 15 s.

4. Let the app analyze automatically.
5. Choose a stage (ACUTE / MODERATE / RESOLVED) and start listening at a comfortable volume.
6. If in doubt about your hearing or tinnitus itself: see an ENT physician or audiologist first.

9. Selected References

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